

HERBIVOROUS INSECTS ASSOCIATED WITH THE PAPERBARK TREE *MELALEUCA QUINQUENERVIA* AND ITS ALLIES: II. GEOMETRIDAE (LEPIDOPTERA)J.K. BALCIUNAS¹, D.W. BURROWS², and E.D. EDWARDS³¹ United States Department of Agriculture, Australian Biological Control Laboratory, Australian Centre for Tropical Freshwater Research, James Cook University, Townsville, Qld, 4811.² Australian Biological Control Laboratory, Australian Centre for Tropical Freshwater Research, James Cook University, Townsville, Qld, 4811.³ C.S.I.R.O. Division of Entomology, G.P.O. Box 1700, Canberra, A.C.T. 2601**Abstract**

Although *Melaleuca* spp. trees and shrubs are diverse, common, and widely distributed throughout Australia, there are few literature records of insects from them. Since late 1986, surveys have been conducted in northern Queensland, south-eastern Queensland, and northern New South Wales to detect insects with potential for controlling *M. quinquenervia* in Florida, USA, where it has become a serious pest. Over 400 species of herbivorous insects have been found associated with this tree, and its close allies, in eastern Australia. This paper presents our records, including brief descriptions of several larvae, for 17 species of Geometridae moths collected and reared on *M. quinquenervia* and three closely related species. Literature references, where available, to other host plants of each of these moth species are provided. Four of these Geometridae species may be considered for further research as biocontrol agents for *M. quinquenervia*.

Introduction

The native Australian broad-leaved paperbark tree *Melaleuca quinquenervia* (Cav.) S.T. Blake (Myrtaceae), was introduced into Florida, U.S.A., as an ornamental at the beginning of this century. For many years, this tree caused no problems and was even considered to be a worthwhile and beneficial plant (Morton 1966). However, in the last 30 to 40 years, it has greatly expanded its range in southern Florida, and now infests nearly 200,000 hectares (Cost and Craver 1981), causing extensive environmental and economic damage.

The native habitat of *M. quinquenervia* is in swamps and wetlands along the eastern coast of Australia, as far south as Sydney, but is also found in New Caledonia and New Guinea (Holliday 1989). It is widely planted as an ornamental in Australia. Blake (1968) placed *M. quinquenervia* with nine other closely related species in the *Melaleuca leucadendra* (L.) L. complex.

With around 250 species (Barlow 1986), *Melaleuca* is the third most diverse angiosperm genus in Australia, behind *Acacia* and *Eucalyptus*. Despite this high level of diversity and abundance, records of moths from *Melaleuca* spp. are comparatively few. McFarland (1979) lists 16 moth species with *Melaleuca* hosts and Common (1990, Appendix B) lists a further 10 moth species with recorded *Melaleuca* field hosts. That same Appendix lists 22 other plant genera that are hosts for an equal or greater number of moth species. Most collecting and rearing of moths (and other insects) appears to have been concentrated in the more populous areas and states, or upon commercially important plants. It is likely that more intensive collecting from the many species of *Melaleuca* trees and shrubs, will add many additional moth species.

In 1977, a preliminary six week survey in Brisbane and New Caledonia to detect potential biological control agents for *M. quinquenervia*, found more than 40 species of herbivorous insects (Habeck 1981). In 1986, funding was obtained to begin the long-term overseas research necessary to find and evaluate potential biological control agents. This project is now run by the Australian Biological Control Laboratory (ABCL), one of the overseas laboratories of the United States Department of Agriculture, in co-operation with CSIRO Division of Entomology, and James Cook University's Australian Centre for Tropical Freshwater Research.

By the end of 1991, our surveys had detected over 400 species of herbivorous insects upon six *Melaleuca* species (Balciunas, *et al.* in press). Balciunas, *et al.* (1993) presented host and collection records for the 25 species of Noctuoidea moths collected during these surveys. One of the largest Lepidopteran families in the world, the Geometridae, is represented in Australia by 1300 species in 275 genera (Common 1990). This paper, the second in a series, presents host records and observations of the 17 Geometridae moth species which we have reared from *M. quinquenervia* and its close allies.

Methods

The majority of the moth caterpillars were collected in our quantitative samples, which, at the end of 1991, totalled 834 samples. Collecting methods were described in Balciunas, *et al.* (1993). Briefly, for each quantitative sample, approximately 1 kg of plant material was collected in the field, then sorted in the laboratory. These quantitative collections were supplemented by direct collections of insects from the field and on our shadehouse cultures. One of the authors (E.D. Edwards) identified the Geometridae adults. The staff of the ABCL reared Geometridae larvae and associated them with the identified adults.

The Geometridae moths were collected and reared on *M. quinquenervia* (539 quantitative collections) or three of its close relatives in the *M. leucadendra* complex; *M. leucadendra* (173 collections), *M. viridiflora* Sol. ex Gaertn. (21), and *M. new sp. A* (24). *Melaleuca new sp. A* is a distinctive, linear-leaved *Melaleuca* species, frequently encountered along the streams west of Townsville, which according to Bryan Barlow (personal communication), will be considered as a new species in his forthcoming monograph on *Melaleuca*.

Our collecting was concentrated in two main regions along the east coast of Australia. In northern Queensland (NQ), our regularly sampled sites ranged from the Daintree River, north of Cairns, to Townsville. Sites marked with an asterisk (*) are either ornamental plantings, or forest remnants in urban areas. The NQ sites referred to in the text are: **Apex Park*** (19°21.7'S 146°43.9'E), Rasmussen, Townsville; **Armstrong Street*** (19°16.7'S 146°48.0'E), Townsville; **Barretts Lagoon** (18°02.7'S 145°58.8'E), 14 km SW of Tully; **Cardwell Swamp** (18°16.6'S 146°02.2'E), 2 km SE of Cardwell; **Centenary Park*** (16°54.0'S 145°44.8'E), Cairns; **Feluga Site 2**

(17°54.9'S 146°00.6'E), 10 km ENE Tully; **Feluga Site 3** (17°52.9'S 146°00.0'E), 13 km NE of Tully; **Forrest Beach West** (18°42.6'S 146°17.4'E), 16 km SE of Ingham; **Hubinger Road** (18°13.3'S 145°58.7'E), 7 km NW of Cardwell; **Hyde Park Shopping Centre*** (19°16.5'S 146°47.6'E), Townsville; **James Cook University*** (19°19.9'S 146°45.5'E), Townsville; **Murrigal** (18°04.8'S 145°54.4'E), 16 km S of Tully; **Pallarenda Retirement Home*** (19°13.1'S 146°46.5'E), Townsville; **Woodward Park*** (16°54.2'S 145°44.5'E), Cairns; **Rockingham Road** (18°00.2'S 145°57.6'E), 9 km SW of Tully; **Stratford Road*** (16°52.8'S 145°44.5'E), Cairns; and **Three Mile Creek Park*** (19°12.9'S 146°46.5'E), Townsville.

Our second major collecting region stretched from Coolumb in south-eastern Queensland (SQ) to Grafton in northern New South Wales (NSW). The SQ sites referred to in the text are: **Bribie Island Road** (27°04.6'S 153°00.6'E), 45 km N of Brisbane City Centre; **Browns Plains** (27°39.5'S 153°0.2'E), Logan City, 21 km S of Brisbane City Centre; **Burpengary** (27°9.5'S 152°58.4'E), 34 km N of Brisbane City Centre; **Caloundra** (26°47.8'S 153°06.9'E), 75 km NNE of Brisbane City Centre; **Chelmer*** (27°31.0'S 152°58.3'E), Brisbane; **Fitzgibbon** (27°20.1'S 153°1.8'E), Brisbane; **Gailes*** (27°35.9'S 152°55.1'E), Brisbane; **Indooroopilly*** (27°30.7'S 152°59.8'E), Brisbane; **Morayfield** (27°07.3'S 152°58.5'E), 45 km NNW of Brisbane City Centre; **Palm Beach** (28°6.7'S 153°27.3'E), Gold Coast; **Sherwood*** (27°31.8'S 152°58.8'E), Brisbane; **Stapylton** (27°43.93'S 153°15.8'E), 35 km SE of Brisbane City Centre; **Taringa*** (27°29.62'S 152°28.47'E), Brisbane; and **Tibrogargan** (26°55.79'S 152°57.31'E), 60 km NNW of Brisbane City Centre.

We also present several records from NSW: **Byron Bay Industrial Park*** (28°38.46'S 153°36.17'E), 55 km SSE of Coolangatta; **Junction Hill*** (29°29.0'S 152°55.5'E), 3 km NNW of Grafton; **Lennox Heads** (28°44.83'S 153°35.75'E), 75 km SSE of Coolangatta; and **Pottsville** (28°22.8'S 153°34.4'E), 23 km S of Coolangatta.

Results

Records for Geometridae Larvae Reared on Hosts

Specimens were reared on the tree species from which they were collected. Unless otherwise noted, the specimens were collected on *M. quinquenervia*.

Aeolochroma quadrilinea (Lucas).

According to Common (1990, p.371), "*Aeolochroma* Prout contains 15 extremely cryptic species".

Apex Park: *M. leucadendra*. Adult emerged from green larva collected 13.viii.90 and reared on foliage. **Bribie Island Road:** Larva collected 9.vii.91, reared on foliage, adult emerged 2.ix.91. **Morayfield:** Adult reared from larva collected 16.vii.91 and reared on foliage.

Anisozya (previously *Eucyclodes*) *pieroides* (Walker).

This species occurs in the Northern Territory and from Cooktown to Port Macquarie (Common 1990). The larvae of this species are brown with flanged body segments. They rarely move, even when disturbed, and the

curved position in which they hold their body enables them to resemble a dead leaf. Larvae pupate in a silk net suspended between two stems or between leaves bound together by silk and frass. Common (1990) reports that the polyphagous larvae feed on young leaves of *Eucalyptus*, *Syzygium leuhmannii*, *Fenzlia obtusa* (all Myrtaceae), *Terminalia* (Combretaceae), *Acacia* and the introduced *Mimosa pigra* (both Mimosaceae) as well as various cultivated plants including avocado, cherry, rose, guava and mango flowers. Jones and Elliot (1986) also report callistemons, *Rhodamnia argentea* (both Myrtaceae), *Acacia fimbriata* and phyllodinous wattles (Mimosaceae) and *Macadamia* spp. (Proteaceae) as larval host plants.

Browns Plains: Larva collected 8.iii.88, reared on flowers, pupated 25.iii.88, adult emerged 11.iv.88. **Burpengary:** Larva collected 21.ix.88, not reared. Larva collected 8.xi.88, not reared. **Chelmer:** Adult emerged from flower-feeding larva collected 21.v.87. **Fitzgibbon:** Larva collected 5.vii.89, not reared. **Gailes:** 2 larvae collected 4.iii.87, not reared. Larva collected 1.iv.87, not reared. **Indooroopilly:** Adult emerged from flower-feeding larva collected 26.iv.88. Larva collected 25.vii.88, reared on leaves, pupated 29.vii.88, adult emerged 29.viii.88. **James Cook University:** Larva collected in Geoscience car park 25.vi.91, reared on flowers and foliage, pupated 2.vii.91, adult emerged 26.vii.91. **Junction Hill:** 2 larvae collected 16.i.89, not reared. **Lennox Heads:** Larva collected 5.vi.90, reared on leaves, pupated 19.vi.90, adult emerged 19.vii.90. **Palm Beach:** Larva collected 1.viii.89, reared on leaves, pupated 21.viii.89, adult failed to emerge. **Woodward Park:** Larva collected from within inflorescence 29.viii.90, adult emerged 13.ix.90. **Pottsville:** Larva collected 6.vi.89, not reared. **Sherwood:** Larva collected 10.vii.87, not reared. **Stapylton:** Larva collected 29.v.90, fed on leaves but died before pupating. **Tibrogargan:** Larvae collected 8.iii.89, not reared.

"Boarmia" lithina (Warren).

McFarland (1979) found or reared five species from this genus on members of six plant families, none of which were Myrtaceae.

Barretts Lagoon: 2 cm brown looper larva collected 12.iii.91, pupated 1.iv.91, adult emerged 11.iv.91. **Bribie Island Road:** Adult emerged from foliage-feeding larva collected 27.1.87. Larva collected 20.xii.89, reared on leaves, pupated 4.i.90, adult emerged 10.i.90. **Burpengary:** Larva collected 6.ii.90, reared on leaves, pupated 12.ii.90, adult emerged 27.ii.90. **Caloundra:** 2 larvae collected 29.i.90, reared on leaves, one pupated 22.ii.90, adult emerged 7.iii.90. Larva collected 7.xi.90, reared on leaves, pupated 14.xi.90, adult emerged 27.xi.90. **Hubinger Road:** Larva collected 27.ii.90, fed on leaves, pupated 5.iii.90, adult emerged 22.iii.90. **Hyde Park Shopping Centre:** *M. leucadendra*. 4 larvae collected 21.vi.90, reared on leaves, 2 pupated 27.vi.90, 1 adult emerged. **Indooroopilly:** Adult emerged from foliage-feeding larva collected 21.vi.88. **Junction Hill:** Adult emerged from foliage-feeding larva collected 17.i.89. **Woodward Park:** 3 larvae collected 20.viii.90, reared on, and pupated in flowers, 1 pupated 13.ix.90 and emerged 23.ix.90, 2 others pupated 17.ix.90 and both emerged 27.ix.90.

Chloroclystis insigillata Walker.

The larvae of this species are pale, greenish-white with black dots down their back. This species is also known as a resident of Norfolk Island (Holloway 1982), which is outside of the native range of *M. quinquenervia*.

Cardwell Swamp: Larvae collected 11.vii.88, fed on flowers, 2 adults emerged. **Feluga Site 2:** 7 larvae collected 11.vi.88, fed on flowers, 5 adults emerged 22.vii.88. **Rockingham Road:** *M. viridiflora*. Larvae collected 12.iii.91, reared on flowers, at least one adult emerged 1.iv.91.

Chloroclystis sp. C

Chelmer: Adult emerged from flower-feeding larva collected 21.v.87. **Edmund Kennedy National Park:** Larva collected 11.vii.88, adult emerged 25.vii.88. **Sherwood:** Adult emerged from flower-feeding larva collected 1.vii.87.

Cleora repetita Butler.

This species occurs in the Northern Territory and from Cape York to northern N.S.W., as well as Indonesia (Common 1990). Reported larval food plants include *Fenzlia obtusa* (Myrtaceae) (McFarland 1979), *Mimosa pigra* (Mimosaceae) (Wilson *et al.* 1990), *Sida acuta* (Malvaceae) (Wilson and Flanagan 1990), *Eucalyptus pilularis*, *Callistemon saligna* [sic] (both Myrtaceae), *Flindersia australis* (Rutaceae) and avocado (Lauraceae) (Common 1990).

Indooroopilly: Adult emerged from larva collected 26.iii.87 and reared on saplings. Larva collected 30.iv.90, reared on saplings; pupated 4.vi.90, adult emerged 2.vii.90. Larva collected 12.xi.90, reared on saplings, pupated 4.xii.90, adult emerged 17.xii.90. **James Cook University:** Larva collected 9.x.89, reared on leaves of juvenile tree, pupated 13.x.89, adult emerged 23.x.89.

Cleora sp. B

James Cook University: Adult emerged from larva collected 25.iii.91 and reared on a sapling.

Comostola laesaria (Walker).

The larvae of this species are up to 15 mm long and white coloured, with a dark-brown head capsule.

Byron Bay Industrial Park: Adult emerged from flower-feeding larva collected 17.vii.88. **Palm Beach:** 4 larvae collected 17.iv.88, reared on flowers, 2 pupated 28.iv.88, 2 adults emerged 9.v.88, 2 pupated 3.v.88, 2 adults emerged 9.v.88 and 10.v.88 respectively. **Taringa:** 2 larvae collected 9.iv.91, reared on flowers, 1 adult emerged 13.v.91.

Gymnoscelis lophopus Turner.

This species occurs in coastal areas from Cairns to northern N.S.W., with the larvae being reported to feed on flowers of *Acacia* (Mimosaceae) and *Lantana* (Verbenaceae) and sometimes damaging the flowers of *Macadamia* (Proteaceae) (Common 1990).

Feluga Site 2: 2 larvae collected 11.vii.88, fed on flowers and leaves, 1 adult emerged.

Hypodoxa erebusata (Walker).

This species has also been included in the genera *Aeolochroma* [sic], *Pingasa* and *Terpna*, but will be included under *Hypodoxa* in the forthcoming Catalogue of Australian Lepidoptera.

Armstrong Street: 2 leaf-mimicing larvae collected 18.iii.91, reared on foliage, pupated 1 and 6.iv.91 respectively, 2 adults emerged 14 and 22.iv.91 respectively.

Hyposidra janiaria Guenée.

Young larvae (< 1 cm) are black with several thin white stripes around their body. As they grow, the white stripes disappear. By the time the larvae are 2 cm long, they have a grey, speckled body, with yellow spots forming bands around each segment. According to Common (1990), this species is common in north-western Australia, Northern Territory and from Cape York to central Queensland, and their larvae have been reported from soybean *Glycine max* (Fabaceae) and *Citrus* (Rutaceae). Wilson *et al.* (1990) reared this species from the introduced species, *Mimosa pigra* (Mimosaceae). All of our specimens have been collected from our shadehouse *Melaleuca* cultures, and have never been found in any of our field collections.

James Cook University (Biosciences shadehouse): 2 larvae collected 26.x.89, reared on leaves, pupated 6.xi.89, 2 adult males emerged 10 and 12.xi.89 respectively. *M. new sp. A.* Larva collected 6.xi.89, reared on leaves, pupated 27.xi.89, adult male emerged 5.xii.89. Adult female emerged from foliage-feeding larva collected 16.xi.89. **James Cook University (USDA shadehouse):** Adult male collected 7.iii.90. Larva collected 29.viii.91, reared on leaves, pupated 27.ix.91, 2 Tachinidae (Diptera) parasitic flies emerged 9.x.91. Larva collected 13.ix.91, pupated 14.ix.91, adult female emerged 1.x.91. *M. new sp. A.* Larva collected 26.x.89, reared on leaves, pupated 12.xi.89, adult male emerged 20.xi.89.

Lobus lithinopa (Meyrick).

This larva is green-brown with a brown head capsule.

Armstrong Street: 8mm larva collected 18.iii.91, reared on leaves, pupated 9.iv.91, adult emerged 17.iv.91. **Indooroopilly:** Larva collected 12.ii.88, reared on leaves, pupated 28.ii.88, adult emerged 8.iii.88. **Pallarenda Retirement Home:** Larva collected 20.ii.90, fed on leaves, pupated 2.iii.90, adult emerged 20.iii.90. **Woodward Park:** Larva collected 4.v.87, pupated 21.v.87, adult emerged 1.vi.87. **Stratford Road:** *M. leucadendra*. Adult emerged from foliage-feeding larva collected 25.v.87.

Metallochloa militaris (Lucas).

McFarland (1979) reared one adult of this species on *Averrhoa carambola* (Oxalidaceae).

Feluga Site 2: Larva collected 28.v.91, reared on flowers, adult emerged 1.viii.91.

Syneora hemeropa (Meyrick).

McFarland (1979) reared three other species of *Syneora*, each on a different species of *Melaleuca* in South Australia.

Bribie Island Road: Adult emerged from foliage-feeding larva collected 27.i.87.

Thalasodes quadraria Guenée.

The narrow, elongate, green larva is pointed at both ends. The ventral portion of the head is produced into a large, laterally-bilobed structure that resembles the anal prolegs. A red, dorsal stripe runs the full length of the body.

Cardwell Swamp: Larva collected 11.vii.88, reared on flowers, adult emerged 8.viii.88. **Centenary Park:** Larva collected 15.vi.88, reared on flowers, adult emerged 24.vi.88. **Feluga Site 2:** Adult emerged from flower-feeding larva 28.v.91. **Feluga Site 3:** Larva collected 16.vi.91, adult emerged 8.vii.91. **Murrigal:** Adult emerged from larva collected 12.xi.90. **Woodward Park:** 2 adults emerged from 3 larvae collected 9.vii.90. **Stratford Road:** *M. leucadendra*. Larva collected 16.vi.91, not reared. **Three Mile Creek Park:** *M. leucadendra*. Adult emerged from flower-feeding larva collected 25.vii.90.

Uliocnemis partita (Walker).

This species can be found from Cape York to northern New South Wales, and also occurs in India and Borneo (Common 1990), which is outside of the range of occurrence of *M. quinquenervia*, but within the range of the closely related *M. cajuputi* (Blake 1968).

Three Mile Creek Park: *M. leucadendra*. Larva collected 25.vii.90, reared on flowers, adult emerged 14.viii.90.

Undetermined Geometridae sp.

Feluga Site 2: 2 larvae collected 11.vii.88, reared on flowers, 2 adults emerged 28.vii.88. **Forrest Beach West:** Larva collected 30.v.88, reared on flowers, adult emerged 27.vi.88.

Discussion

Although *Melaleuca* is a diverse and widespread genus, little is known about the herbivorous insects associated with it. Of 280 Australian moth species whose food plants were recorded by McFarland (1979), 155 were Geometridae, but only 9 of these had *Melaleuca* hosts. Of the dozen moths listed by Common (1990) in Appendix B (p.490) as having *Melaleuca* spp. hosts, none were Geometridae. Thus, the host records for the 17 Geometridae species presented in this paper are apparently all new.

Despite their diversity and herbivorous habits, Geometridae have seldom been used as biological control agents. Of 83 Lepidoptera species recorded by Julien (1992) as having been used for biological control of weeds, only 3 were Geometridae. Currently, none of the Geometridae species from *M. quinquenervia* are being studied as biological control agents, although "*Boarmia*" *lithina*, *Comostola laesaria*, *Lobus lithinopa* and *Thalasodes quadraria* may be worthy of further investigation if sufficient numbers are collected.

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